



MISSOURI Natural Areas

N E W S L E T T E R

2021
Volume 21, Number 1

"...identifying, designating, managing and restoring the best remaining examples of natural communities and geological sites encompassing the full spectrum of Missouri's natural heritage"

Editor's Note

Missouri's Mammals

In the past ten years, populations of Missouri's large native carnivores, black bear (*Ursus americanus*) and mountain lion (*Puma concolor*), have experienced a marked increase. Today, black bear populations in Missouri are estimated at 500 to over 800 individuals based on extensive surveys and research conducted between 2010 and 2019. The recovery of black bears in the state is strong, even warranting a regulated hunting season for the first time in 2021, and sightings and encounters have been reported even

American black bear (*Ursus americanus*). This issue highlights animal illustrations of longtime MDC mammalogist Charles W. Schwartz.



in highly urban areas. Since 1994, the Missouri Department of Conservation (MDC) has confirmed 86 sightings of mountain lions with the earlier specimens moving through the Missouri River corridor from South Dakota. In the near future, this recent increase in large carnivores in Missouri may prove to keep certain animal populations in check, to the benefit of all biodiversity. This issue focuses on some of the more secretive and lesser well-known mammals that inhabit our state. Notable publications have extensively addressed our charismatic megafauna, including [this story map](#)¹ of the almost decade-long black bear research.

Research in Missouri is also showing impacts to our mammal populations caused by an increase in different wildlife diseases. This issue will examine trends in our cave bat populations since White Nose Syndrome found its way to Missouri in 2010. Chronic Wasting Disease is impacting white-tailed deer in Missouri and MDC now regularly conducts tests on harvested

¹ <https://mdcgis.maps.arcgis.com/apps/Cascade/index.html?appid=712cc83bff5145808936d38a3822ebb7>

deer during hunting season to help track its spread. In the article about swamp rabbits in southeast Missouri, learn about a disease that impacts rabbits that has not yet been documented in wild populations in Missouri but in other nearby states.

But first, we will highlight the work of long-time MDC mammalogists Charles W. and Elizabeth R. Schwartz who penned *The Wild Mammals of Missouri*. Illustrations from this landmark publication will accompany the subsequent articles, ranging from Southern flying squirrels to swamp rabbits. Now in its third revised edition (2016), *The Wild Mammals of Missouri* remains a standard text for budding and seasoned mammalogists. Missouri's long history of wildlife conservation and our thriving mammal populations have offered scientists a virtual laboratory as we continue to learn more about mammal interactions, habits, and impacts to biodiversity.

In Natural Area News, learn about recent natural area nominations including Greer Spring, long-recognized as a premier example of a phreatic spring. Department of Natural Resources Natural Areas Chair, Ken McCarty received a prestigious national award for his long tenure and history of protecting not only state park lands, but state and regional ecosystems. To learn more about Missouri Natural Areas and to read previous issues of the newsletter, visit the Missouri Department of Conservation website.²

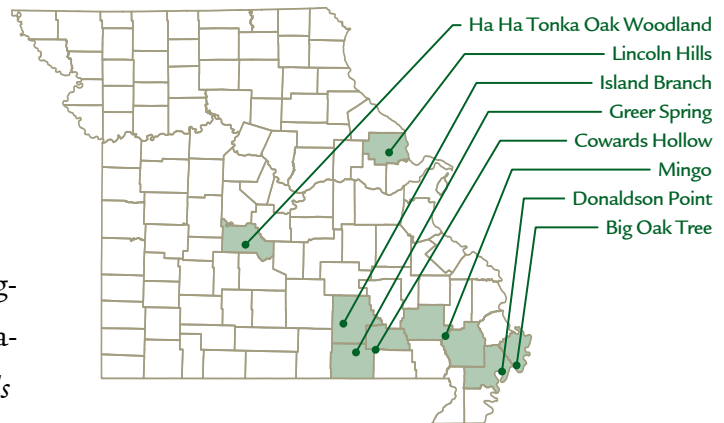
— Allison J. Vaughn, editor 🌿

Allison J. Vaughn is the Natural Areas Coordinator with the Missouri Department of Natural Resources.

Contact: allison.vaughn@dnr.mo.gov

² <https://mdc.mo.gov/discover-nature/places/natural-areas>

NATURAL AREAS FEATURED IN THIS ISSUE



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The Missouri Natural Areas Newsletter is an annual journal published by the Missouri Natural Areas Committee, whose mission is identifying, designating, managing and restoring the best remaining examples of natural communities and geological sites encompassing the full spectrum of Missouri's natural heritage. The Missouri Natural Areas Committee consists of the Missouri Department of Natural Resources, the Missouri Department of Conservation, the U.S. Forest Service, the U.S. Fish and Wildlife Service, the National Park Service and the Nature Conservancy.





Charlie painted the Missouri wildlife mural at the MDC Headquarters in Jefferson City.

Charles W. Schwartz and the *Wild Mammals of Missouri*

by Timothy Barksdale

I reached up to the large reference section of my bookshelves and pulled one thick book down. As the book touched the desk, while slipping from my grasp, the cover was accidentally flung open. Suddenly transformed, it produced a long tailed, buffy white and orange mouse--it ran off the page, scurried across the desk, leapt down, and bounded right out the door! The book was of course *The Wild Mammals of Missouri* by Charles W. and Elizabeth R. Schwartz.

Flipping through each page of *The Wild Mammals of Missouri*, first published in 1959, one seems to find a new gem of an illustration. Every portrait of each animal is as if you could touch the fur, feel the bone, hear the crunch of the foot in the snow or smell the odors. The pose of the animals involved actually does seem to come off the page and come to life. The life of the animal, deeply felt in each drawing, is the work of a man whose genius was a product of

his intense appreciation, skills of observation, education and affinity for all things natural. The joyful passion which surrounded Charles W. Schwartz (1914–1991), known by many as Charlie, followed him everywhere, and thus he shared it with those who were ready.

As a filmmaker, artist, writer, photographer, scientist, father, husband and observer Charlie is unmatched and needs no comparisons to elevate his stature. From a very young age, Charlie attracted attention because of his almost obsessive curiosity, his obvious skill set and demonstrated ability to affectionately (compassionately?) understand animals of every type. In the preface to *The Wild Mammals of Missouri*, the Schwartzes write that the Missouri Conservation Commission had “long recognized the need for such a reference.” Unquestionably, this was true, but the rarity of the moment was clear: here was a gifted pair of scientists, well-versed in mammalogy, and one of them happened to be an extraordinary artist.

It is important to point out very early that when one writes that Charles W. Schwartz accomplished anything, it is with the significant understanding that his wife Elizabeth Schwartz (1912–2013) was in a very deep sense a co-creator. Charlie and Libby were each individually gifted scientists, but as a team, they were nothing short of formidable. However, Charlie was the artist. Every single illustration in *The Wild Mammals of Missouri* reveals his depth of knowledge and substantial amount of experience the artist spent watching—and even living with—many of the creatures he portrays. Hours and hours of observations, the noticing of a tiny detail or a behavior unique to the animal, perhaps a method of chewing into an acorn, or a specific way of constructing a burrow, gives the reader a glimpse not only into the creature’s life, but

actually also into the author and illustrator. We need to understand the illustrator’s personality to more clearly understand what was brought to life in the Schwartzes’ books.

Born in St. Louis in 1914, Charlie displayed an early passion for nature while bringing home every frog, snake or refugee squirrel; he tamed and hand-fed crows. Charlie deemed no creature unworthy of attention. His immediate magnetic attraction to nature flowed naturally, and he inspired others from a very early age. After entering the U.S. Army and attaining the rank of sergeant, Charlie became a disciplined leader. The toughness of the training enhanced his sense of strictness, which never became overbearing. But he was not a pushover either, even in later years after becoming a grandfather. His enthusiasm never waned. As conservation writer Joel Vance recalls:

The best way I can sum it up was what [fellow writer] John Madison said about Charlie. John was my favorite outdoor writer of all time. He was of equal stature

Libby Schwartz examining specimens of small mammals in preparation for writing the text of *The Wild Mammals of Missouri*.

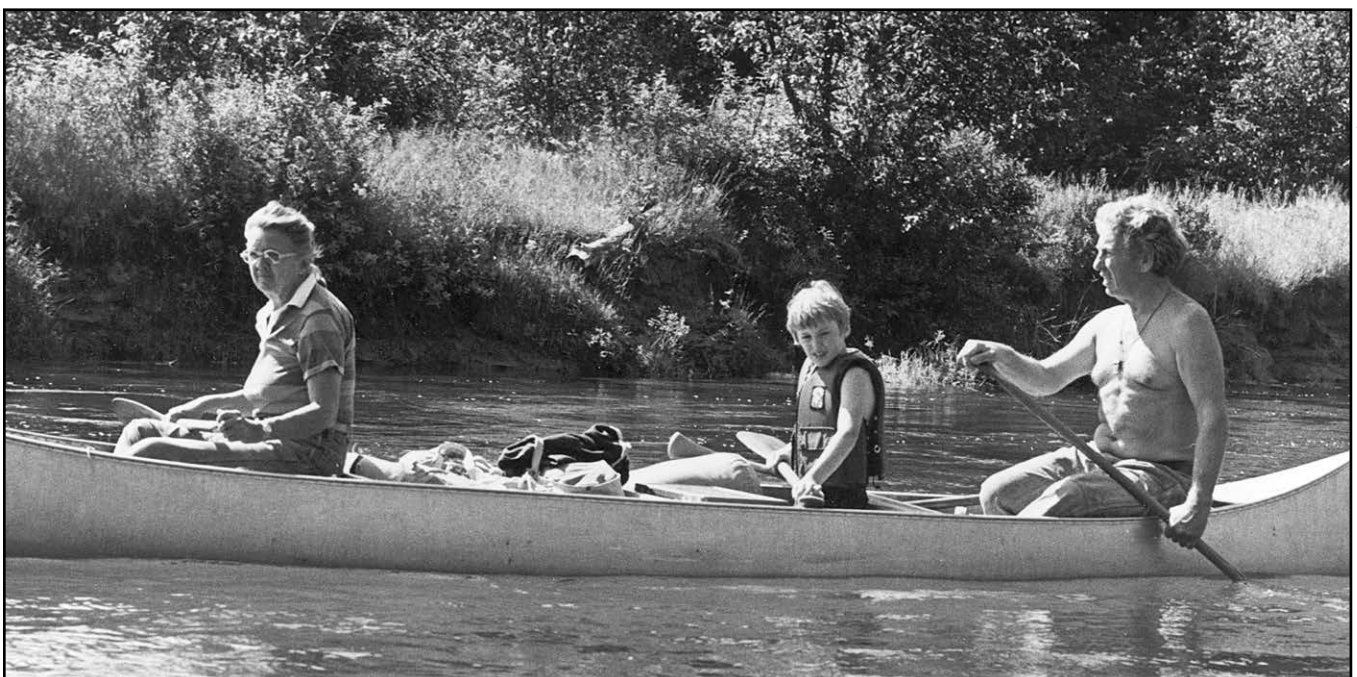


to Charlie Schwartz. John went to Charlie's house one day and Charlie was in the backyard and had just gotten a new canoe. He was sitting in this canoe with a paddle out in the middle of the yard, not in water, and he was pretending to paddle because he wanted to kind of get the feel of the canoe. John looked at him and he said, 'Charlie Schwartz, 70-something-years old going on 15.' And that summed up Charlie. He was absolutely the most enthusiastic man I've ever known and the only true genius. He was an absolute genius and Libby, his wife, was his equal in everything. I think Charlie was the erratic genius and Libby was sort of the balance beam. She was the one that kept him from flying off into outer space. Because Charlie was pure enthusiasm and Libby was practical, and common sense, she would essentially try to tame a wild horse. She was the one that broke Charlie when he needed to be broken.

Thinking about the natural world during the early years of Charlie Schwartz's youth pulls one back into a time not long after the extinction of the passenger pigeon in 1914, the near complete destruction of the Ozark pine ecosystems, and the rapid decline of many other wildlife populations. It was this period that eventually gave rise to the conservation movement in Missouri, well-documented in numerous publications. The destruction of the natural world motivated people like the Schwartzes, and continues to motivate many conservationists today. Charlie and Libby deeply felt the need to conserve, and sharing their love of nature was a natural expression of that desire for conservation.

The text of *The Wild Mammals of Missouri* is straightforward and balanced, conveying the solidity of facts. Before its publication in 1959, forty-seven mammal species' accounts were published in the *Missouri Conservationist* each month between July 1953 and September 1957. Libby was clearly the main author and editor of the text, so one can see how their personalities add a

Libby, grandson Craig Miller, and Charlie canoeing in an Ozark stream.



Photos courtesy of the Schwartz and Miller Families



Charlie liked to use live animals as models for his illustration. Here he is with a model, a Canada goose, who posed for a painting.

dynamism to the book: the unbridled passion for wildlife and the steady hand of pragmatism worked together for this masterpiece. Because it is impossible today to know exactly which passage was added to or completed by either one member of this team, the theme of this article will be in direct reference to the art and illustrations, because we know those are all Charlie's.

Charlie Schwartz's Passion:

Today, we think we know what passion is, but passion is expressed when time disappears and nothing is left but focus and deep involvement, when the universe melts away and there

is only the subject and the observer, everything else—hunger, pain, and time itself—all fade into “other” and are not a part of things—until one snaps back out. Suddenly, it is 2 a.m. and one realizes that they are tired. It is time to rest. Even in normal life, each of us glimpse concentration. Being good at what you do transcends the normal, transporting the individual into a space where creative and active are linked with the background. You step into the portal and the surroundings are a new world. It looks exactly the same, but time and presence are “other.” Many of Charlie's moments filled with this kind of passion and creativity came late

at night when things calmed down around the house, and even after Libby had gone to bed. The focused sessions began late at night and the routine of disciplined years would kick in.

Charlie was not passive, never bored; his deep attention to the natural world led to his endless fascination and perpetual questions about any and every aspect of wildlife. Reflecting their broad interests, the Schwartzes' house was filled with study skins, photographs, skulls, feathers, artwork and often orphaned creatures. Charlie spent hundreds of hours with mammals of every kind in order to produce the numerous drawings and paintings with a strong artist's sense, yet also accuracy and precision. So the hours spent with deer fawns, raccoons, young rabbits, river otters, grey foxes, flying squirrels and many others allowed Charlie to develop a specific kind of familiarity with his subjects. Charlie lingered for entire days in the St. Louis Zoo observing and photographing captive animals. Because of his hands-on experience with wild animals, he noted the differences in behavior between the wild and the captive. The Schwartzes also had access to helicopters, planes and the ease of travel allowed him a vision. Charlie took hundreds of still images to study each animal. There is something special about a drawing or a fine illustration that cannot be replicated in a photograph, which he used only as reference material.

Charlie completed many of his drawings in either a few minutes or few hours. Some drawings, which may have been intended as the main illustration, instead became useful as ancillary material showing specific actions or behaviors. Years of studying biology, anatomy and dissecting dead mice, roadkill or packing out a deer gave practical experience to depend upon. Volume, even in something as simple as a cylinder, can be turned into a lined and shaded axis of muscles right before one's eyes. Seeing how to

draw things volumetrically is not a simple or common trait. Charlie worked at times with photos often pinned up around the easel, while other times he was surrounded by stacks of photos as a sketch filled out into a creature. Most wildlife artists draw and erase, draw and erase. It may take several attempts to correctly sketch a two dimensional line. Charlie could do it in very few strokes, but the biggest difference was in the dimensionality: one stroke could express the proper depth as well as shape and the formation of the subject...all in ink.

Charlie had an exceptional gift of observation fueled by his passionate desire to see and do it all. In Idaho, groups of pigeons frequented their family farm. One winter, a Northern goshawk took up residence in the area. Once Charlie found out about its presence, everyone in the family was on alert to let him know immediately about the sightings so that he could run out to watch the goshawk chase pigeons, even in the brutally cold Idaho winter weather.

Particularly important to Charlie for his illustrations was the actual wild animal behavior versus the imagined. A New York-based artist ensconced in an apartment forty stories above asphalt or concrete is simply not going to paint every detail accurately. Charlie and Libby added to the authenticity factor by developing a series of notebooks, full of years and years of photos, sketches, field notes and journal notations. Charlie's artistic and accurate excellence was noted by many, including the great land management and wilderness advocate Aldo Leopold. Charlie's illustrations for Leopold's *A Sand County Almanac*, a seminal book providing a land ethic to communicate the true connection between people and the natural world, represent the deep friendship between Leopold and Schwartz. Leopold's untimely death in 1948 tragically ended a relationship which had only just begun.

Charlie's grandson, Craig Miller, reminisces about spending time with his grandfather:

I remember laying on the bank of a large pond with my grandfather watching Canada geese flying, swimming and feeding. Late at night when I was young, when I visited, I was given ice cream and allowed to stay up late. Grandpa would go into his studio and begin a painting or a pen and ink. In a few strokes, lines would express volumetrically the animal's proportions. I would sit quietly in the background, watching in fascination as if I were being initiated into a special world of wonder.

All of this passion and knowledge shared between Charlie and Libby combined for a book, now with a third edition, that continues to serve as a primary text in Missouri schools. Let's examine the typical species description: first, we see the illustration. Looking closer, the sketches of the skulls and always crisp illustrations of the mammal's teeth often include notes about their pattern. Schwartz explains the origin of the species' name in English and Latin, followed by a full species description including color, measurements, teeth and skull, sex and age criteria and ratio, lifespan, glands, and voice and sounds. Following the basic description is the animal's distribution and abundance with preferred habitat and home, habits, details about reproduction, adverse factors, importance in the ecosystem (and, where appropriate, also economic importance), management or control factors, and finally ending with important references.

Overall, the arrangement of *The Wild Mammals of Missouri* follows the scientific order. Because opossums are marsupials, bats are insectivores, mice are rodents and so on, the layout of the book follows standard taxonomic orders of the established phylogeny. In the preface, there is an

excellent introduction that includes a discussion on the naming and organization of the species prior to one key to the whole adult and one key just examining the skulls.

The Wild Mammals of Missouri is a source of continual wonder, especially due to the thoroughness of many details such as bat fur colors; each species' burrow systems and pouches of the pocket gopher, pocket mouse and chipmunk; the differences in the feet of the two species of fox; teeth patterns of voles and the wearing of teeth to age white-tailed deer. All of these nuggets of science, visualized, foster new naturalists.

Among the most thorough descriptions in the book, that of the white-tailed deer, weighs in at an extensive thirteen pages. At the time of publication in 1959, the white-tailed deer population in Missouri was recovering, and significantly lower than even in the late 1970s before the publication of the 1981 revised edition. Noted in Missouri's conservation history, the recovery of this species was largely hailed as a success, but in the 1981 edition, the Schwartzes gave us a glimpse into the future if deer became overly abundant on the landscape, discussing the potential for browse lines and extirpation of native flora. In the 1981 revised edition of *The Wild Mammals of Missouri*, it reads "Populations have reached 'landowner tolerance level' in most agricultural areas. The greatest potential for population increases is in the Ozark Highland." In the third revised edition, edited by esteemed mammalogists Debby K. Fantz and Victoria L. Jackson, the editors recognize that Missouri's deer population has far exceeded any naturally occurring levels and pointed to efforts by the Missouri Department of Conservation to reduce the herd by "significant liberalization of regulations, for example increasing season lengths and bag limits," all aimed towards reducing deer densities. With increased fragmentation of our native habitats

and increased urbanization, deer populations are well above the historic carrying capacity that historic landscapes once heralded. Vehicle mortality and diseases such as Chronic Wasting Disease (CWD) and Hemorrhagic Disease can cause localized decreases in populations, none of which are desired among the citizens who appreciate wildlife in Missouri. But Charlie never saw the deer population increase that we see today. He worked for the Missouri Department of Conservation during a time when deer populations in the state were lower, recovering, and he finally saw it recover. But he wrote extensively about this charismatic megafauna much to the wonder of many who picked up his book, often inspiring students to study mammalogy.

Some have compared Charlie Schwartz to acclaimed wildlife illustrator and birder John James Audubon, but he and Libby need no comparison to reach an elevation of exalted stature. They richly deserve prominent and permanent recognition for their individual accomplishments, as well as the successful efforts of their partnership. Charlie painted hundreds of birds, mammals, lizards and even snails in color, black

and white, and later began to sculpt in bronze. His unique combination of art and science, both quests for knowledge and the means to share it, were driven by an inner fire.

Sixty-two years have passed since the first publication of the Schwartzes' book, making it even more remarkable that *The Wild Mammals of Missouri* remains the finest book on state mammals ever published, with great thanks to the steady revisions provided in the Third Revised Edition by Fantz and Jackson. Every Missourian should possess some amount of pride that such multi-talented people, Charlie and Libby Schwartz, developed their expertise and talents here in a state with such incredible wildlife diversity, while cultivating and enriching so many other lives that they touched through their numerous publications for the young and old alike. 🌿

Timothy Barksdale is a wildlife filmmaker, birder, educator and founder of Birdman Productions.

Contact: Timothy.barksdale@gmail.com

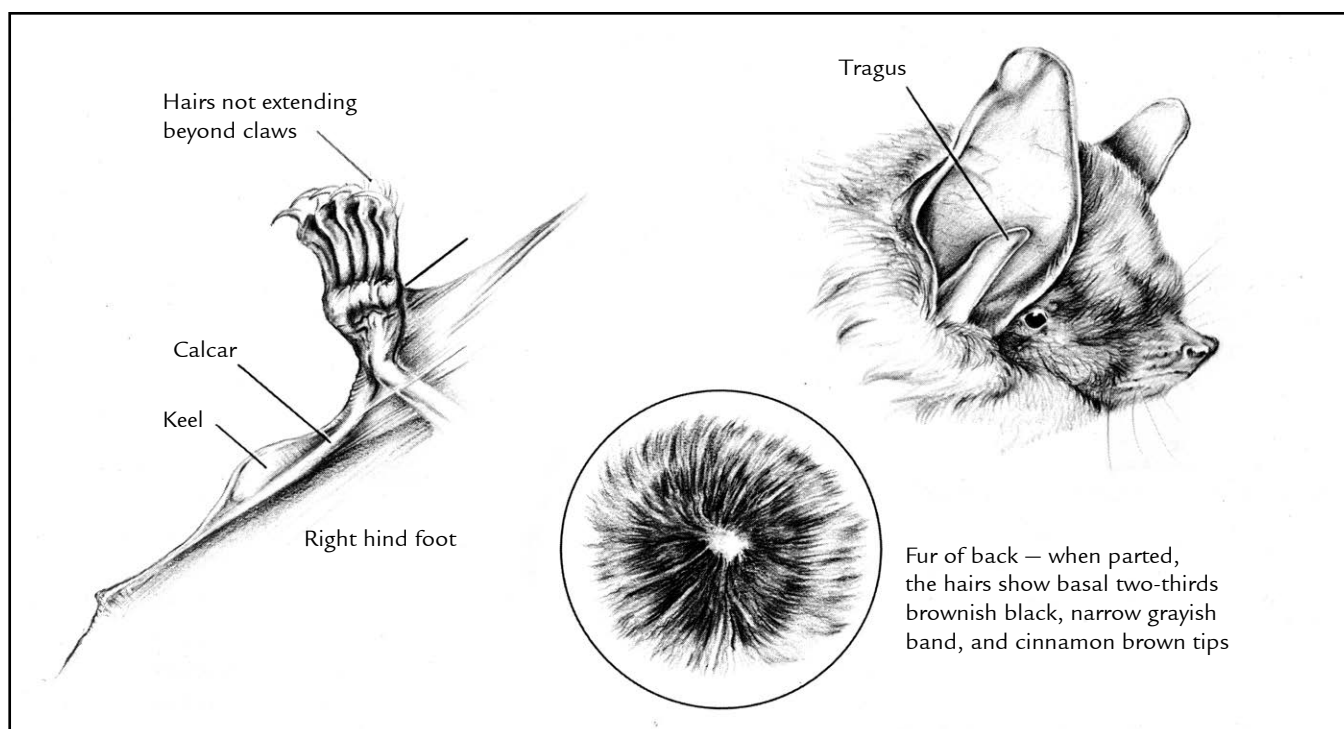
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2022 Missouri Natural Resources Conference



Indiana bat (*Myotis sodalis*)

Shining a Light on the Impacts of White-Nose Syndrome on Missouri's Cave Bat Populations

by Shelly Colatskie

Missouri's team of bat biologists, representing several agencies, non-governmental organizations and volunteers, often share the same personalities of the creatures they study: reclusive, feisty, and not bothered by the late nights. It takes a unique personality to monitor, study, and facilitate conservation efforts for these often-misunderstood mammals. This cohort of biologists have been witnesses to one of the nation's greatest biological tragedies in the form of the white-nose syndrome (WNS) outbreak and decline of several species of cave bats. WNS is caused by the fungus *Pseudogymnoascus destructans* (Pd), and first appeared in New York State in the winter of 2006. Pd is a cold-loving invasive fungus that parasitizes on hibernating bats in caves or mines. Bats are aroused in mid-winter by the irritating

fungus, which causes health declines and eventual mortality for the bats. Following nearly a decade since the first WNS discovery in Missouri, the state's bat experts and others now wonder what the future is for Missouri's cave bats.

Bats are one of the world's most unique groups of mammals. With over 1,400 known species worldwide, bats come in all sorts of sizes and harbor a variety of adaptations. Bat ecological services are well known, especially for pest control, seed dispersal, and pollination. Most of these bat species face threats from pesticide use, habitat loss, roost disturbance, disease, alternative energy platforms, and a bad reputation. Of those 1,400 species of bats, Missouri is home to 16, but they are no less important to our wide array of natural communities.

As a student of biology, I had hoped to work with one of the state's charismatic megafauna such as black bears, but naturally settled for charismatic microfauna weighing in at about 1/4,000th the size. Many late nights were spent under the wing of Dr. Lynn Robbins, capturing bats in a volleyball net-like system called a 'mist net' as they foraged through stream corridors, ponds, or remote gravel roads that served as 'flyways.' Teasing these delicate, squirming bats from tangled filaments of netting without getting bit takes a special skill.

Like many of my colleagues, I look back on pre-WNS fieldwork as the glory days of bat survey work. Many sites we set up from northern Missouri agricultural landscapes to southern Missouri woodlands yielded data sheets with a long list of bat captures from a variety of species. It was not uncommon to capture 40 bats in one evening, especially once the young bats began flying. Bats hung in bags from a clothesline, awaiting to be identified, weighed, and possibly banded and/or fitted with a transmitter.

Once WNS hit the state, busy bat nights became few and far between. Many attempts yielded no bats at all. By 2009, bats in at least nine separate states were impacted by WNS. In 2010, *Pd* appeared in Missouri. Swabs taken from bats at a few sites resulted in a positive finding of the genetic presence of the fungus, but WNS had not yet affected Missouri bats. In response to this, my bat research and monitoring shifted from fields and woodlands to caves. This shift in focus required new skillsets from navigating rugged caves and identifying bats roosting on cave ceilings 30 feet above my head using a telephoto camera lens.

Missouri, known as the 'Cave State' has over 7,500 natural caves, many of which harbor several species of bats. This does not include hundreds of active and abandoned



Photo by Ann Froschauer – USFWS

Author Shelly Colatskie photographs a banded Indiana bat high up on a ceiling at a cave in Oregon County

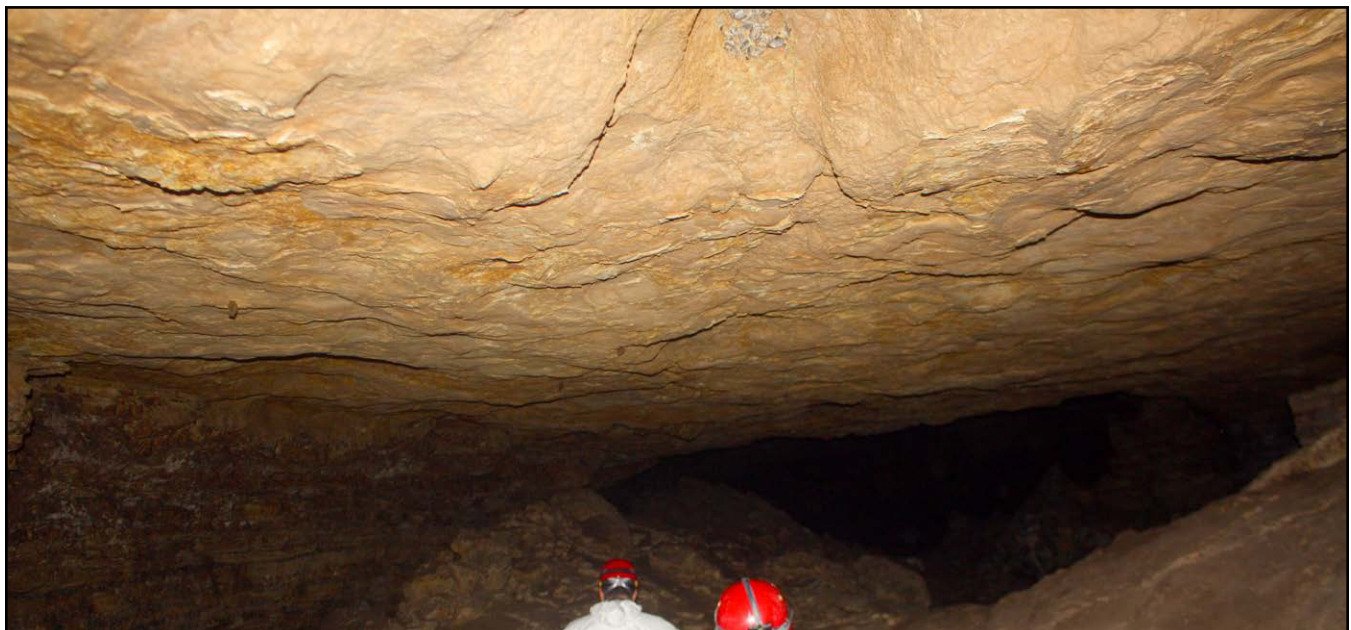
Species	2010/2011	2012/2013	2014/2015	2016/2017	%Change 2010-2017
Indiana bat	12,813	15,428	19,794	17,536	+36.9
Little brown bat	2,413	2,774	2,215	378	-84.3
Northern long-eared bat	508	1,066	1,787	2	-99.6
Tri-colored bat	2,376	4,122	3,188	313	-86.8

Population counts between 2010/2011 and 2016/2017 at 20 Missouri hibernacula of four species with the largest documented declines from WNS in North America



Photos by Shelley Colarskie

Impacts of white-nose syndrome: this cave in Pulaski County shows a large decline in bats from 2013 to 2017. The picture above shows a portion of the cave with scattered bats on the ceiling. This cave during 2013 had a count of 1,235 bats of 5 species in 2013. The picture below of the same area from 2017 shows how very few bats occurred in the cave, which had a count of 35 bats of two species.





Little brown bats at a cave in Washington County in 2013 showing signs of white-nose syndrome. This particular cave had a count of 96 little brown bats in 2013, and only 1 little brown bat in 2019.

mines and quarries which also host bats. Six bat species depend on Missouri's caves at some point in the year including the gray bat, (*Myotis grisescens*), Indiana bat (*Myotis sodalis*), little brown bat (*Myotis lucifugus*), tri-colored bat (*Perimyotis subflavus*), small-footed (*Myotis leibii*), and the Northern long-eared bat (*Myotis septentrionalis*).

From 2010 to 2017, over 800 caves, mines, and quarries were surveyed for winter bat use and WNS occurrence. In the process, some previously unknown bat hibernacula were discovered. One notable site, Lime Kiln Mine in Hannibal, Missouri, now known as Sodalis Nature Preserve, is home to over 200,000 Indiana bats, the largest Indiana bat hibernaculum on the planet.

In 2012, while surveying a cave in Cuivre River State Park near Troy, Missouri, our team of biologists found the first positive case of white-nose syndrome in Missouri. Following the discovery, a variety of state and federal agencies in addition to NGO's and volunteer groups worked together to systematically survey bat hibernacula across

the state. Collectively, these groups would document a substantial decline to near extirpation of some of Missouri's cave bat species. White-nose syndrome traveled rapidly across Missouri. By 2017, the deadly disease was found statewide wherever caves and mines occur. From 2010 to 2017, 20 caves were consistently surveyed on an every other year basis. Species such as the little brown bat, tri-colored bat, and the northern long-eared bat declined 85% to 99% in those caves in that seven-year period (see table opposite page.)

In response to this, most public caves on Missouri Department of Conservation and Missouri State Park lands were closed to public access to protect bats from extra disturbance while they were hibernating and fighting white-nose syndrome. Unfortunately, WNS pushed the northern long-eared bat to be listed as a federally threatened species. It is now rarely observed through routine survey work statewide. I personally have not observed a northern long-eared bat since

winter of 2017. This species had been one of our most common captures during 2008 and 2009. Other species, like the tri-colored bat and little brown bat have been petitioned to be listed as federally endangered.

It can be difficult to glean anything positive from the current status of Missouri's cave bats. However, there is a possibility a slow recovery may be on the horizon. Researchers are documenting traits that are allowing bats to survive the impacts of WNS. Gignoux-Wolfsohn (2021), demonstrated metabolic differences in surviving little brown bats that allow them to more effectively combat and survive the disease. Hasse et. al (2020) demonstrated bats of greater body mass showed higher potential of surviving WNS. Bat biologists in Missouri have observed that the bats that are captured in fall before hibernation have a higher body mass than those measured pre-WNS.

Many people, now more than ever, are working together to protect Missouri's bat species.

A much cherished photo of a banded northern long-eared bat in Powder Mill Creek Cave Natural Area. In 2013 there were 338 northern long-eared bats in this important natural area cave, but by 2019 there were no northern long-eared bats seen in Powder Mill Creek Cave.

Photo by Shelley Colatskie



The level of cooperation between governmental agencies, NGOs, and private organizations has been the key to gaining more knowledge of our state's bat population, as well as educating the public on why protecting our remaining bat populations are so important. Missouri Department of Conservation (MDC) now is opening up a small number of caves to guided educational tours, and all of MDC caves are part of a new citizen science monitoring program and Missouri Department of Natural Resources-State Parks often teams up with MDC staff to conduct public bat research demonstrations.

Because of the wonderful collaborative effort across Missouri, we were able to acquire robust estimates of our cave bat populations prior to, during, and following the wave of WNS. A great example of this teamwork was during the winter of 2015, when we were able to get a small but important estimate of the tri-colored bat populations during the height of WNS in Missouri. In 375 surveyed hibernation sites, 39,736 tri-colored bats were documented. There is hope these species will step away from the edge of extinction, but it is going to take continued efforts in the form of consistent monitoring, research, and protection.

For further information, I can be contacted with questions on Missouri's caves and educational efforts at Shelly.Colatskie@mdc.mo.gov, and Jordan Meyer, our State Bat Ecologist can be reached at Jordan.Meyer@mdc.mo.gov for all questions on Missouri's bats. 🦇

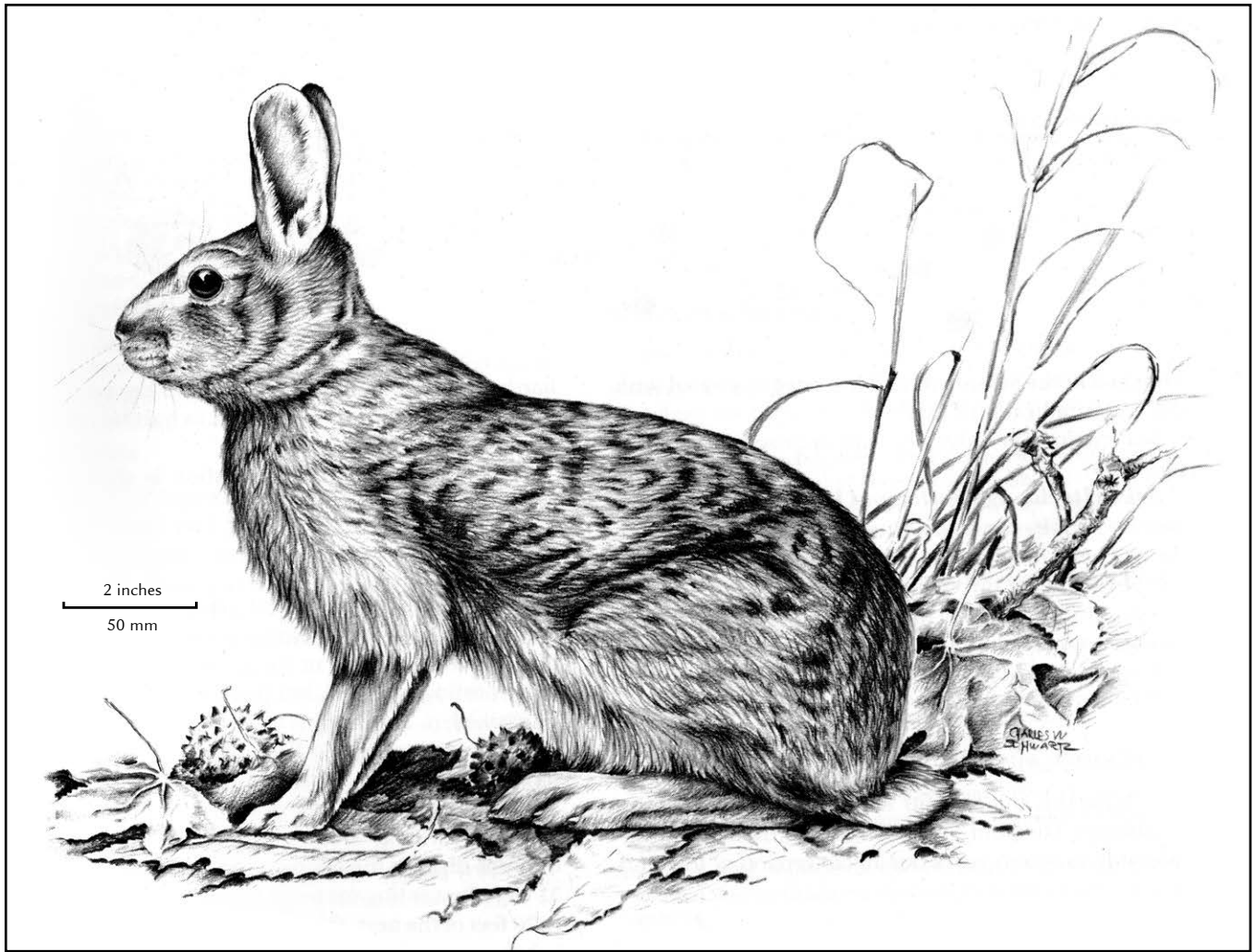
Shelley Colatskie is a Naturalist for the Missouri Department of Conservation

Contact: Shelly.Colatskie@mdc.mo.gov

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Swamp rabbit (*Sylvilagus aquaticus*)

Missouri's Swampers

by Kevin Brunke

They were a mile and a half into a three-mile round trip hike in search of the elusive swamp rabbit (*Sylvilagus aquaticus*). Even though three biologists were among the group of five, they weren't conducting research on this trip, they were hunting rabbits and a swamp rabbit or two would be a welcomed addition to the handful of eastern cottontails (*Sylvilagus floridanus*) they'd already harvested. As the brushy levee, constricted by a deep ditch on one side and a cypress swamp on the other, gave way to an expansive patch of wet bottomland hardwoods, one of the beagles let out a sharp yelp.

That yelp led to another, which attracted the other beagles and before they knew it, a blur of brown fur shot out from a brush pile and the chase was on. The woods filled with the yelps, barks, and howls from the dogs as they chased after the rabbit. As the barks began to fade into the distance, they all realized this chase was different than the others so far that day.

"That rabbit looked big," one of the guys said.

"Swamper," the veteran rabbit hunter simply replied, focused on the different sounds his dogs made in the distance.

Swamp rabbits, or swampers, as many people like to call them, are the largest member of the cottontail genus and are known by rabbit hunters for basically leaving the county when they are jumped by hounds before circling back to where they were initially hiding. They're fast too, about the time the dogs' barks can be heard again, is about the time the rabbit is approaching the location it initially jumped from; the rabbit will be well ahead of the dogs.

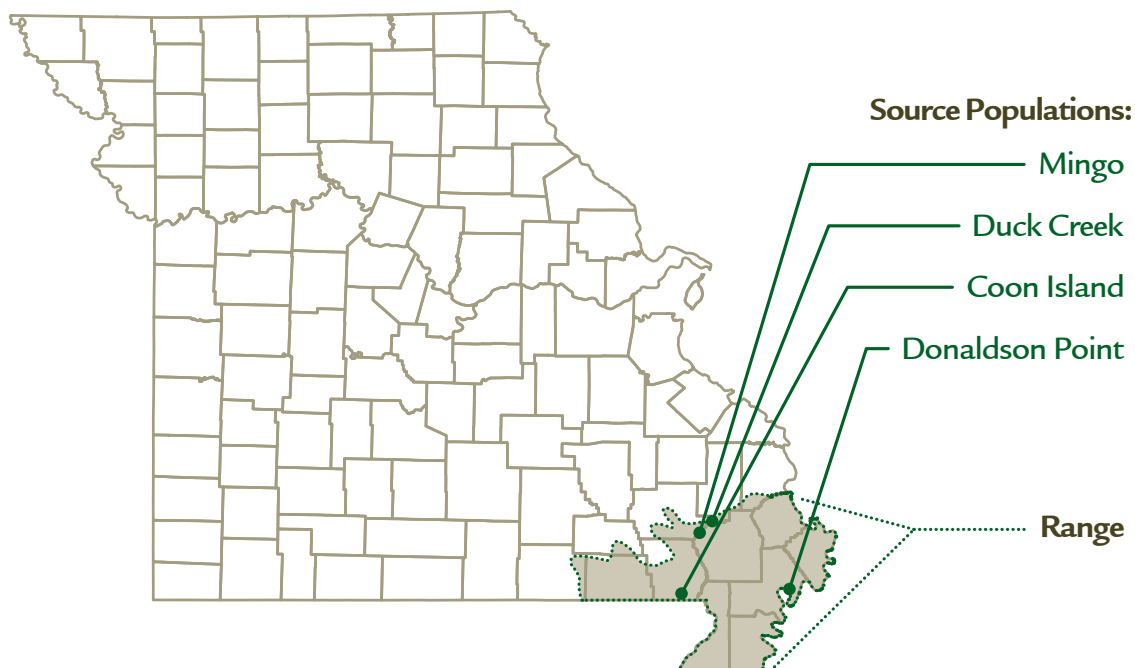
Many rabbit hunters venture down to Southeast Missouri from all over the state each winter specifically to target swampers. However, even if hunting in prime locations in Southeast Missouri, hunters may not encounter swamp rabbits on their hunt. According to hunter harvest data on Otter Slough Conservation Area (CA), swamp rabbits accounted for about 10% of the annual rabbit harvest over a ten-year period (120 average cottontails harvested and 14 average swamp rabbits harvested each year). A higher proportion of swamp rabbits may be harvested on habitats more dominated by bottomland forests, but those data are currently not available.

Swamp rabbit harvest is currently only tracked on a few conservation areas in Southeast Missouri. Missouri's swamp rabbit working group hopes to use citizen science to better track swamp rabbit harvest across its range via a voluntary wildlife observation application in development. In this app, small game hunters would be able to record their harvest, where they hunted, and other data associated with their hunting trip. If adopted by hunters, this could potentially give harvest information down to the habitat patch scale.

Swamp rabbits are unusual for a game animal in Missouri, as they are also a species of conservation concern (SOCC). They are state-ranked as S2, imperiled, but globally secure (G5). Like so many of the other imperiled species in our state, their population has dwindled from historic levels because of habitat loss. Southern Missouri is along the northern edge of the swamp rabbit's range, their populations appear to be more secure in the southern states. As its name implies, swamp rabbits almost exclusively use bottomland forested habitats.

Historically, Southeastern Missouri was covered with large expanses of bottomland forested

Missouri swamp rabbit range (Fantz et al. 2017) and source populations — including Coon Island CA, Mingo National Wildlife Refuge and Duck Creek CA, and Donaldson Point CA.





A swamp rabbit among woody debris in bottomland forested habitat.

habitat that experienced periodic inundation when the numerous meandering rivers and sloughs spilled out of their banks. A study of the General Land Office (GLO) notes from when the land was initially surveyed will also yield frequent references to an understory that was dominated by cane and green briars. Swamp rabbits were probably quite numerous with those habitat conditions. Today, less than five percent of this habitat type still exists in Missouri. The habitat patches are greatly reduced in size and many of the patches are separated by large expanses of open agricultural fields.

Today, swamp rabbits are thought to persist in Missouri as a metapopulation where the network of smaller habitat patches are connected by dispersal and undergo repeated extinction and colonization. There are three large source populations currently identified in Missouri: the area around Coon Island CA, the Mingo National Wildlife Refuge and Duck Creek CA area, and the Donaldson Point CA area. Smaller habitat patches on private land may be destroyed and new habitat patches may be slowly created through long-term conservation easements, like the Wetland Reserve Easement (WRE) program of the Natural Resources Conservation Service.

Currently, it's unknown how the disappearance and recreation of habitat patches influence swamp rabbit populations and metapopulation dynamics. As land managers, the best approach that can currently take place for swamp rabbit conservation is to focus on providing diverse habitat conditions across elevational gradients to ensure the juxtaposition of terrestrial and periodically inundated habitats near the larger source populations. Enlarging the patch size of the smaller habitat patches should also benefit swamp rabbit populations.

The Missouri Department of Conservation, in cooperation with university researchers, systematically monitor swamp rabbit presence or absence in habitat patches periodically. Capturing swamp rabbits is very difficult, but they do have a habit of defecating on elevated surfaces found in their habitat. This habit forms readily observable latrine locations on stumps and logs that researchers can use to document swamp rabbit presence within a habitat patch.

Latrine surveys have been used across the swamp rabbit's range to study the species. Missouri started a latrine survey in the winter of 1991-1992 to determine the distribution of swamper in the state. This survey was



Swamp rabbit fecal pellets deposited on a downed log.

repeated during the winter of 2001 and again during the winters of 2010–2012 with increased search effort. The protocol revisions during the 2010–2012 surveys allowed researchers to better estimate occupancy and detection probability. The occupancy of swamp rabbits ranged from 49% in suboptimal habitat to 72% in optimal habitat. Detection probability ranged from 57% in suboptimal sites to 90% in optimal sites. These decadal surveys will hopefully be repeated during winter of 2022–2023 if funding is approved.

Flood frequency and duration along the Mississippi River has increased in recent years and in 2011, river levels got so high that the Birds Point-New Madrid floodway was activated by using explosives to blow holes in portions of the flood protection levee. Activating the floodway meant approximately 130,000 acres of land within the floodway became rapidly inundated with flood waters. Data from the decadal surveys and site surveys in and around the floodway after it was activated suggested that swamp rabbit occupancy dropped dramatically after this flood event. Occupancy rates went from 79% in 2011 to 26% in 2012. Occupancy rates within the floodway did recover fairly rapidly with rates rebounding to 40% in 2013 and 68% in 2014.

Surveys within the floodway are occurring again this winter with the addition of a few new sites that haven't been previously surveyed. Over

11,000 acres of habitat have been enrolled in the WRE program within the floodway and little is known about swamp rabbit occupancy of these newer habitat patches. Studying restored habitats and how rabbits use them will help researchers and land managers better understand when these habitats become occupied by rabbits and how they fit into the overall metapopulation.

There's still a lot to learn about swamp rabbits, but as long as habitat connectivity and survival rates do not decrease, the species shows strong resilience for long-term survival in Missouri. One emerging threat that thankfully has not been found in Missouri yet is Rabbit Hemorrhagic Disease Serotype 2 (RHDV2). RHDV2 affects all species of rabbits and can have a mortality rate of over 90%. The restricted habitat and distribution of swamp rabbits in Missouri makes this disease worrisome. Although RHDV2 has not been found in Missouri, researchers conducting latrine surveys will follow new biosecurity protocols as an added precaution to prevent any potential disease spread.

The hunters from the beginning of the article didn't get that swamper they chased, it took to the cypress swamp and the dogs lost its trail. Nevertheless, the thrill of the chase and catching a brief glimpse of this secretive species is more than most Missourians will get to experience. Hopefully many future generations can come to Missouri's remaining bottomland forests and experience a bit of the natural history that makes Southeast Missouri so unique to the state. 🐇

Kevin Brunke is a Natural History Biologist with the Missouri Department of Conservation

Contact: Kevin.Brunke@mdc.mo.gov

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Southern flying squirrel (*Glaucomys volans*)

Mind the Gap: Overcoming Movement Barriers for Missouri's Flying Squirrels

By Richard Essner and Jeremy Howard

Flying Squirrel Ecology

Southern flying squirrels (*Glaucomys volans*) are among the most enigmatic of Missouri's native fauna. These fascinating gliding mammals are difficult to observe due to their nocturnal habits, high degree of arboreality, and small body size. They are an integral part of a healthy forest ecosystem, interacting with a diverse array of species throughout the food web.

Flying squirrels are important prey for a host of mammalian, avian, and reptilian predators, and are themselves omnivores, feeding on a variety of hard and soft mast, leaf buds, fungi, eggs, nestlings, insects, and carrion. Their generalized diet is matched by generalized habitat requirements. They can thrive in even highly disturbed wooded habitats, as long as tree cavities are present for shelter. Their abundance in optimal habitat can

even exceed that of their tree squirrel relatives, with reported densities as high as 13.8 individuals/ha (Sonenshine et al. 1979).

Given their abundance and broad dietary and habitat requirements, wildlife professionals could be forgiven for not giving flying squirrel populations much consideration. However, in highly fragmented landscapes, their presence cannot be assumed. Occupancy surveys of southern flying squirrels across an array of forest patch types in eastern North America have found that they are generally present in larger, well-connected forests, but are often extirpated from smaller, isolated patches (Rosenblatt et al. 1999; Walpole and Bowman 2011). Their absence from small forest patches has generally been attributed to poor dispersal across open habitats.

The unique anatomy of flying squirrels makes them superbly adapted to gliding, but limits their ability to move terrestrially. They have relatively elongated limbs compared to tree squirrels, with higher intermembral ratios (forelimb length/hind-limb length; Thorington and Heaney 1984; Essner 2007). These morphological adaptations facilitate gliding by increasing the size of the patagium (gliding membrane), while providing additional shock absorption when landing on vertical trunks (Paskins et al. 2007). However, they come at a cost. A study of quadrupedal locomotion in the closely related northern flying squirrel (*Glaucomys sabrinus*), showed increased travel time, corresponding to an increased risk of predation. In addition, the energetic cost of quadrupedal locomotion is higher in flying squirrels than in tree squirrels (Flaherty et al. 2010). Given that gliding is also less energetically expensive than quadrupedal locomotion in most contexts (Scheibe et al. 2006), it is not surprising that flying squirrels avoid moving long distances over ground.



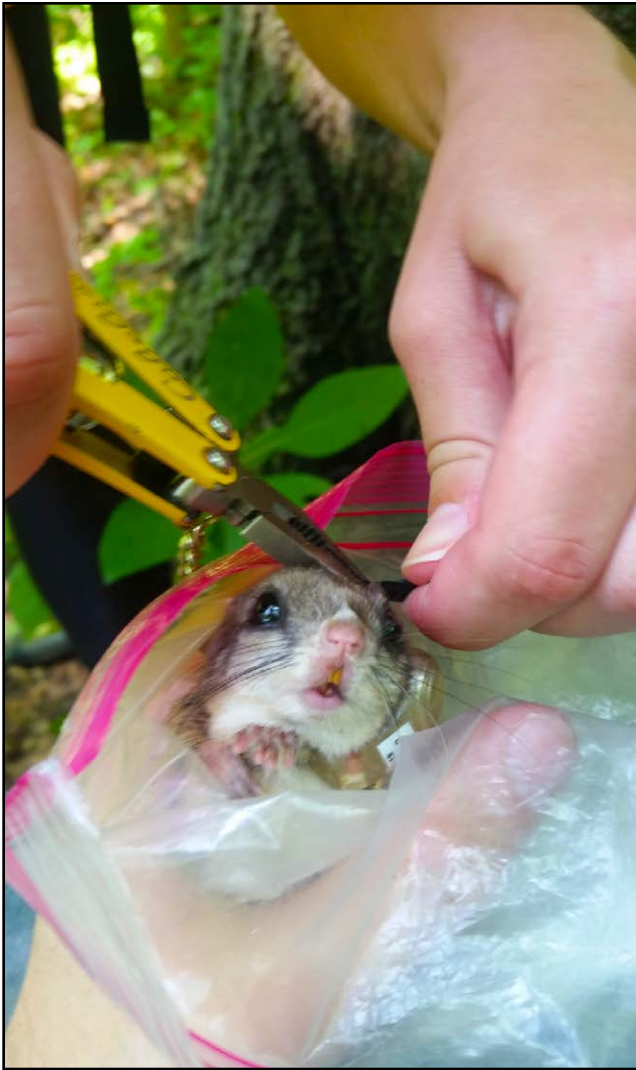
Photo by Jeremy Howard

Southern flying squirrel preparing to launch from a vertical trunk following release.

Forest Fragmentation

Missouri's forests are inundated with roads, clearcuts, and transmission corridors that can easily be crossed by tree squirrels, but which act as movement barriers to flying squirrels. An inability to move among forest patches can lead to local extinctions due to reduced genetic diversity and stochasticity (Howard et al. 2020). Roads, in particular, have a negative impact on flying squirrel movement patterns.

A radio-telemetry study of Humboldt's flying squirrel (*Glaucomys oregonensis*), in the Cascades of Washington, determined that they were capable of crossing roads when canopy gaps were less



Jeremy Howard fitting a captured flying squirrel with a radio transmitter.

than 50 m, but were unable to cross when gaps exceeded 80 m (Smith 2011). In the Appalachians of North Carolina, federally endangered Carolina flying squirrels (*G. sabrinus coloratus*) were unable to cross a highway with an average gap of 38 m, until pairs of crossing structures (utility poles with a horizontal beam placed at the top) were installed on both sides of the road to narrow the distance (Kelly et al. 2013). This practice was adopted based on studies of gliding marsupials that demonstrated their effectiveness in restoring connectivity for multiple species (e.g., Ball and Goldingay 2008; Asari et al. 2010). Crossing structures used to restore connectivity in Caro-

lina flying squirrels consisted of 16.7 m wooden utility poles with a horizontal beam placed at the top (See this YouTube video¹; Kelly et al. 2013).

The conditions under which southern flying squirrels are able to successfully cross gaps are poorly understood. To elucidate this, we used radio-telemetry to track flying squirrel movements on the campus of Southern Illinois University Edwardsville (SIUE). The campus is located within the St. Louis metropolitan area along the bluffs of the Mississippi River. It consists of 2,660 contiguous acres, with a central core of academic buildings and dormitories, surrounded by a mosaic of forest and prairie habitats intersected by roads and parking lots. We were fortunate to document a road crossing event at a distance of ~40 m (Howard et al. 2020; Howard and Essner 2020). The likely route was a thin line of trees that extended towards the road from one of the forest patches. We used gliding performance data from Scheibe and Robins (1998) to estimate the range of horizontal distances that could be traveled under average, minimum, and maximum gliding performance scenarios (Howard and Essner 2020). The vertical height of the presumed launch tree was 23.8 m. Using trigonometry, we determined that this was more than sufficient to allow crossing with even average gliding performance. Assuming maximum gliding performance, the vertical height could have been as low as 6 m.

Management Recommendations

To simplify things for management purposes, a good rule of thumb is that flying squirrels are capable of gliding horizontal distances that are around twice the vertical height of their launching position (Kelly et al. 2013). We recommend that wildlife managers adopt the practice

¹ https://www.youtube.com/watch?v=s4FLAitN2_4

of measuring the shortest horizontal distance across a forest gap, then measuring the vertical height to the tallest unobstructed horizontal branch from trees located on both sides of the gap, to ensure crossings can occur from either direction. If the horizontal distance is equal to or less than twice the vertical height, then it can be assumed that flying squirrels can cross the gap. If it is greater than twice the vertical height, then consider reducing the distance by planting lines of fast-growing trees on either side of the gap or possibly installing crossing structures to facilitate movement. A little forethought can ensure that flying squirrels remain an abundant species in Missouri's forests. 🌳

Richard Essner is Professor of Biological Sciences at Southern Illinois University Edwardsville

Contact: ressner@siue.edu

Jeremy Howard is a masters graduate from Southern Illinois University Edwardsville and a doctoral candidate at University of Missouri—St. Louis

Contact: jeremy.howard@mail.missouri.edu

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Road crossing on the SIUE campus. A radio-collared male flying squirrel crossed from a 79-ha forest patch to an 84-ha forest patch in April 2018 using the line of trees on the left of the photograph. Surrounding habitat on the left consisted of a restored tallgrass prairie, which made a terrestrial crossing unlikely.



Photo by Jeremy Howard



White-tailed deer (*Odocoileus virginianus*)

A History of Managed Deer Hunts in Missouri State Parks

by Allison J. Vaughn

The leading statement in the mission of Missouri State Parks is “to preserve and interpret the state’s most outstanding natural landscapes and cultural landmarks....” To that end, for over 40 years the Natural Resource Management Program has initiated and continued ecosystem restoration efforts ranging from prescribed fire, ecological thinning, glade and wetland restorations and other projects to restore and preserve our state park native landscapes.

In the mid-1980s and 1990s, white-tailed deer herbivory began to increase to noticeable levels in state parks, negatively impacting ecosystem restoration efforts and general park plant life. State parks are known as lands for wildlife preservation by tradition, with a game refuge status as outlined in the state statutes. Protected as lands with “No Hunting” allowed (with some 1970s-era boundary signs still standing in the backcountry of older state parks), the Missouri

	1987-1988	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Knob Noster	179	384	234	148	128	71		94		134	87				133	100	76
Pershing	63	260			156	27		62	50	90	92	70			237	111	167
Thousand Hills	87											54	67	5			
Truman			83	48				59			59						91
Crowder								69	65		83	98	45	24	88		
Watkins Mill								38	44	71	116	107	63	40	101	23	61
Cuivre River										156	286	254	174	44	24		110
Babler											89	21	80	86	46		77
Big Oak Tree														10	10	16	4
Meramec															75	64	
Rock Bridge															85	72	54
St. Francois															54	46	
Stockton															170	47	34
Weston Bend																	
St. Joe																	
Ha Ha Tonka																	
Pomme de Terre																	
Mark Twain																	
Montauk																	
Bennett																	
Long Branch																	
Season Total	329	644	317	196	284	98	0	322	159	451	812	604	429	209	1023	479	674

	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	Park Total
Knob Noster	56		96	75	59	66		76		72				119	76	117	2580
Pershing	87		108	87	66						89	28			74	28	1952
Thousand Hills	42		73														328
Truman					81					32						13	466
Crowder	101	79	77	58			49				44	43					923
Watkins Mill	38	77	36	30	50	59		54	34		14						1056
Cuivre River		140		41			74		66		65	26					1460
Babler	46	43	44	23	30				56	35	20		12		39	28	775
Big Oak Tree																	40
Meramec																	139
Rock Bridge		73	52					44									380
St. Francois		29								37	8	5					179
Stockton						17	40			34			24			38	404
Weston Bend	30	16		21													67
St. Joe				84								90			32		206
Ha Ha Tonka							85	63		36					42		226
Pomme de Terre								10			14	8	10		14	5	61
Mark Twain													80			14	94
Montauk													23		10		33
Bennett															17		17
Long Branch															24	14	38
Season Total	400	457	486	419	286	142	248	247	156	246	254	200	149	119	328	257	11424

The Department of Natural Resources maintains a master spreadsheet of deer harvested during each successive hunt. This spreadsheet illustrates the sum total of deer harvested during managed hunts through 2020.

Department of Conservation and others grew concerned that parks were becoming reservoirs of high deer populations which could contribute to vehicle collisions, crop depredation, and garden damage in surrounding areas. State park staff began to consider deer population reductions in parks that were under browse pressure and exhibiting an ecological imbalance affecting plant life and other park wildlife. But browse pressure was not confined to state parks during this time, and in the 2016 edition of *The Wild Mammals of Missouri*, revised by Debby K. Fantz and Victoria L. Jackson, the authors note:

“However, as populations grew rapidly over the 1980s and 1990s issues of overabundance occurred.... Efforts to reduce the deer population led to significant liberalization of regulations, for example increasing season lengths and bag limits, aimed at reducing deer densities. These efforts, along with shifting hunter attitudes towards antlerless harvest, have resulted in stable or reduced numbers. Today, the major consideration of deer management is the localized regulation of annual harvest by hunters to maintain stable populations at biologically and socially acceptable levels.... Uncontrolled herds of high density can alter local plant-deer relationships such that grazing results in local extirpation of sensitive plants.” (p.409)

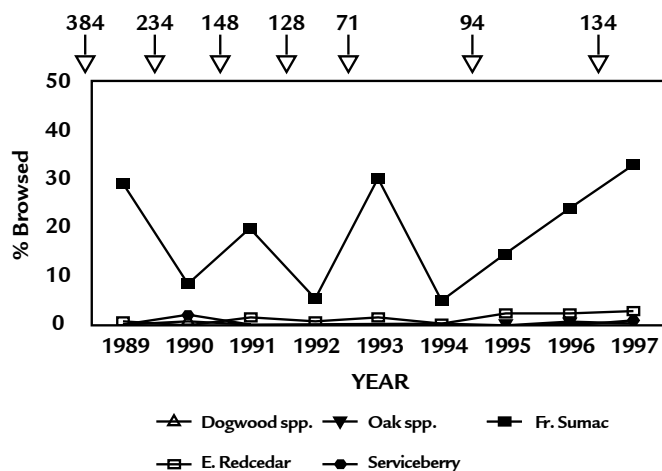
In 1986, the Missouri Department of Natural Resources' Natural History Section contracted University of Missouri wildlife professor, Dr. Ernie P. Wiggers, to initiate a decade-long deer population survey in Missouri state parks. In the first year of the study, Wiggers engaged with park and section staff to establish winter twig browse utilization surveys, biweekly roadside spotlight counts, and adjacent cropland depredation

surveys at Harry S Truman, Knob Noster, Cuivre River, Meramec, Pershing and Thousand Hills state parks. Because no single technique (except aerial surveys) is definitive, state parks took this multipronged approach to assess deer populations. The purpose of the surveys was to quantitatively assess deer densities and measure impacts to park vegetation in an effort to help guide management decisions to address high deer densities and overbrowse. MDC's Lonnie Hanson conducted deer population modeling with this data to determine the need for high deer harvest numbers and modern weapons. In subsequent years, other parks were added to Wiggers' survey efforts, mainly in the north and west Missouri agricultural zones. The study revealed that deer browse was negatively impacting vegetation structure and abundance in state parks, and the need for managed hunts was clear.

Wiggers employed the traditional deer census technique with the winter twig browse surveys that used changes in utilization of key indicator species to index relative browsing pressure from year to year. These winter twig browse surveys became the backbone of the deer study: preferred and non-preferred species were chosen averaging five to ten species across twelve linear transects. The percentage of browsed to unbrowsed twigs is calculated, and assessments are made based on

2016 Ha Ha Tonka SP deer browse results. After tallying the browsed versus unbrowsed, preferred and unpreferred winter twigs in the mid-2000s, staff can track the trends to help guide managed hunts.

Species	Average Browse %
Smooth Sumac	27.2
Fragrant Sumac	17.4
Sassafras	16.2
White Oaks	1.8
Black Oaks	1.7
Black Hickory	1.3
Flowering Dogwood	0.0



Results of winter deer browse surveys conducted within Knob Noster SP, 1989–1997. (Arrows indicate special hunts and number of deer harvested) Levels of browse and successive hunts showing how the browse decreased following the hunts to more acceptable deer density levels.

the pressure by deer. For example, flowering dogwood is a known preferred species for browsing, while bitternut hickory is not. When the browse pressure on preferred species results in multistem and stunted plants that cannot form into mature trees or shrubs, this is an indication of overbrowse. In general, heavy and prolonged deer pressure causes a reduction in tree recruitment and a shift in the structure and composition of the understory plant community. The repeated twig browse surveys at these pilot parks showed that when deer densities were reduced to at or below 25 deer/mi.², browse pressure was reduced. The standard of 25 deer/mi.² as the maximum carrying capacity will prove that even at that density, browse will stress some aspects of our plant communities in state parks.

Aside from the winter twig browse surveys, in the mid-1990s, park staff erected twelve plots in multiple parks, six of which in each park remain enclosed by wire to prevent deer from entering. These were surveyed annually and measured herbaceous species and cover data, total species richness, and comparisons of utilization patterns by species between the enclosed and unenclosed areas were conducted. Enclosures were also estab-

lished in 1995 around specific populations of yellow ladies slipper orchids at Meramec SP and Pickerelweed Pond in the Lincoln Hills Natural Area at Cuivre River SP. With this new method, in the most profound cases of overbrowsing, researchers noted a shift to a sedge and fern-dominated understory or one dominated by lawn-like ground covers of *Sanicula* like the image from Babler SP illustrates (opposite page). Inside the enclosure, the *Sanicula* was an erect herb, but outside the enclosure it formed as a ground cover. Less common species, such as ginseng, a preferred browse species, became suppressed or even locally extirpated under prolonged browsing. For some dominant and characteristic woodland herbaceous plants when deer densities are high, flowering is substantially reduced, which leads to low numbers of native pollinators and in the end can cause a trophic cascade effect in our natural communities. At the plant community level, the increased light levels below the browse lines foster increased plant production, dominated by less-preferred grasses, sedges, and ferns (Russell, 2001). Species richness and diversity were shown to indicate a decline in the most prolonged cases of high deer density monitored in the study with one of the most dramatic instances occurring at Watkins Mill SP when the population was estimated at 180 deer/mi.².

Deer enclosures have proven to provide long-term trends in plant community differences between enclosed and unenclosed plots. Wiggers' study showed that in parks where the enclosures have existed for eight to ten years, there developed a marked compositional difference in the paired transects. Outside of the enclosure, there was a grass, sedge, and fern community with the dominant species of *Diarrhena obovata*, *Cystopteris fragilis*, *Carex rosea*, and *Carex jamesii*. Inside the enclosure, after several years of protection, these same species became minor mem-



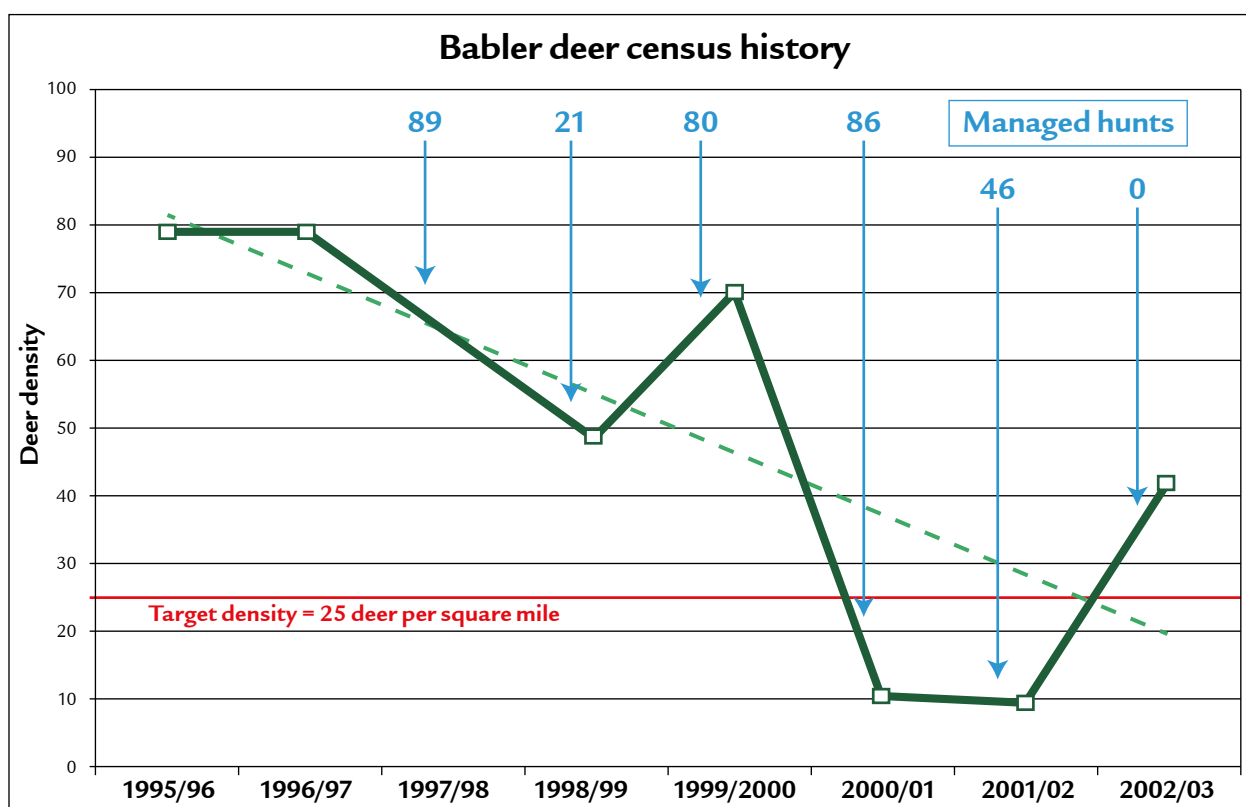
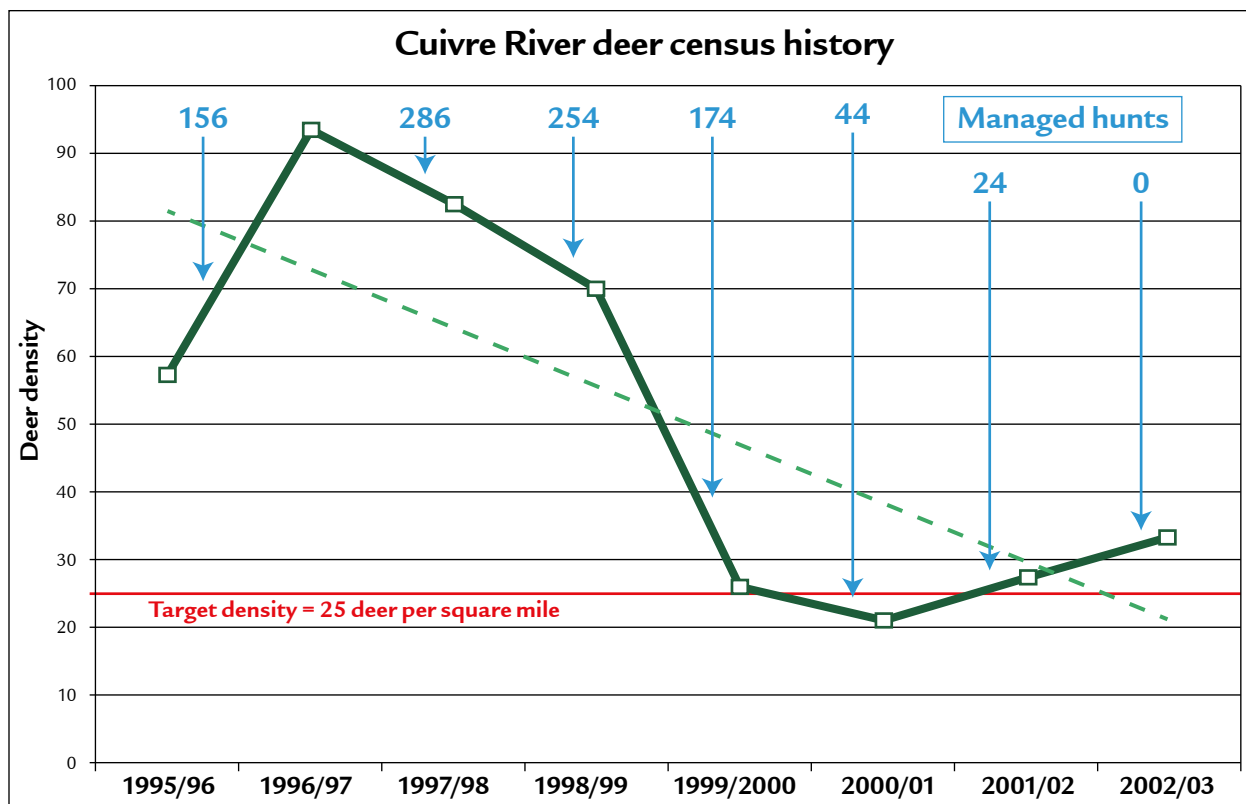
(above) Former Park Scientist Margaret Magai surveys inside and outside the deer enclosure at Babler SP. Outside the deer enclosure, data show a dominant groundcover of *Sanicula* growing prostrate rather than an erect herb.



(above, below) Pickerelweed Pond illustrating how prolific the pickerelweed is inside the enclosure and veritable absence outside the enclosure. Located in the Lincoln Hills Natural Area at Cuivre River SP, these data indicate that pickerelweed is indeed a preferred browse species by deer.



bers of the understory as a wider variety of more typical woodland herbs came to dominate. By the mid-2000s, and with rising urbanization at other parks' borders, ecologists noted high deer browse pressure at parks heretofore that had not had high density issues. At Pomme de Terre SP, for example, one of the first parks to witness thinning and prescribed fire events that resulted in a robust woodland forb vegetation cover, in 2011, resampling the vegetation transects first established in the mid-1980s revealed a depressed understory dominated by woodland grasses and sedges. Furthermore, high deer densities at Pomme de Terre SP have resulted in an extirpation of preferred browse species, including *Camassia angusta*, once tracked by the Natural Heritage Program. Winter twig browse surveys at Pomme de Terre SP beginning in 2010 were fruitless as the preferred shrubs and saplings available for sampling were located within the



These graphs show the change in browse pressure as a function of deer density. Note the decrease in density after significant harvest numbers, and the increase following years without hunts. Deer census data was obtained by helicopter counts over snow. The density was calculated as actual count +22%.

deer exclosure, along with the only other known populations of woodland herbs like *Brickellia grandiflora* and *Clematis pitcheri*. In the mid-2000s, state parks continued to add parks to the list for conducting spotlight surveys and aerial deer censuses to assess deer populations; 1990s-era exclosures are periodically revisited at Coonville Creek Natural Area at St. Francois SP, and in 2009 erected in the Ha Ha Tonka Oak Woodland Natural Area at Ha Ha Tonka SP after anecdotal evidence indicated the need for such trend data.

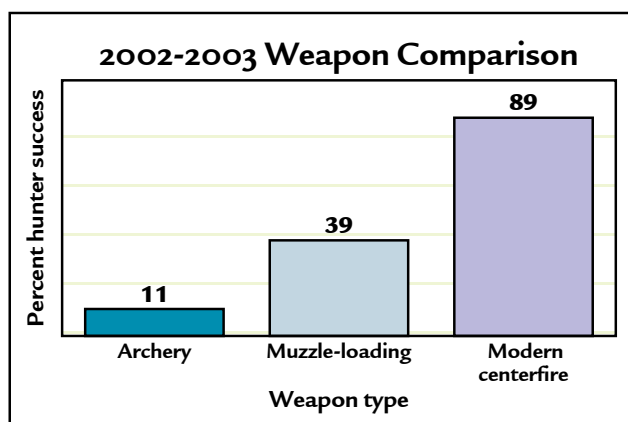
Today, aerial surveys during snow events and roadside spotlight data continue to be employed when possible. In the early years of the deer surveys, the aerial surveys were used in combination with the winter browse surveys, spotlight counts, and exclosures to come to a decision if a hunt was necessary. These same methods are used to determine the need for a hunt, especially in parks with a growing deer population that have not previously conducted a managed hunt. While park staff do not conduct all intense surveying from Wiggers' study, each winter Missouri State Parks recommends parks in need of managed hunts to the Department of Conservation with data indicating need, whether aerial survey, spotlight counts or browse surveys. The authority for removing deer from state parks comes from a state statute, which limits such activity to when deer cause damage to park resources, the most basic of native vegetation, and/or adjacent private resources.

It was not until November 1987 following the Wiggers study that state parks conducted the first managed hunt with modern weapons. At Knob Noster SP in 1987, hunters harvested 179 deer; at Pershing SP 63 deer; and Thousand Hills SP 87 deer. Between 1969 and 1978, Knob Noster SP conducted annual archery hunts that were not successful at reducing the herd, with the annual harvest in the single digits; in 1980, they hosted a

historic weapons hunt that, again, did not prove to reduce the herd to acceptable browse levels. At Knob Noster SP, one of the parks with perennial deer overpopulation issues, it took three years to remove 797 deer with modern weapons to begin to see a difference in the vegetation response. As another of the early 1980s pilot parks for ecosystem restoration and home to the Pin Oak Slough Natural Area, Knob Noster SP, located in a largely agricultural setting, continues to host deer hunts based on data collection that, on average, result in the harvest of 80 to 100 deer each year. Beginning in 1987 and continuing to 1996, hunters harvested between 94 and 148 deer (2.6 to 4.2 deer/acre) annually before being able to maintain acceptable browse utilization. Throughout the history of managed deer hunts in state parks, the highest number of deer harvested at a managed hunt was 384 from Knob Noster SP over a weekend during the second deer reduction hunt in the late 1980s.

Managed deer hunts in state parks were contentious among the public statewide. There was a distrust of the state park system that they would open the gates to hunting at all times. After repeated public meetings explaining the need to save the respective parks' natural history, there were still protests. In a historic newspaper clip-

Following the early years of archery and muzzle loader hunts, staff mapped success rates showing modern weapons were significantly more effective at harvesting deer.



ping from the *St. Louis Post-Dispatch*, in response to a managed deer hunt proposed to take place at Babler SP in 2000, protestors arrived at the park holding signs discounting the need for managed hunts, though aerial surveys the previous winter indicated 65 deer/mi.². In the article about the protest, MDC's Mike Helland reported that since 1997 the managed hunts have proven successful in lowering the problems associated with overpopulation such as vehicle accidents, residential property damage and overbrowsing on the park's native vegetation. With the introduction of modern weapons at Babler SP, harvest jumped from 29 deer harvested in 1998 with muzzle-loaded weapons to 80 deer harvested the following year. By winter 2020, 21 state parks and historic sites have hosted at least one managed hunt.

Knob Noster SP continues to lead parks with the highest total deer harvest of 2,580 since 1987. Throughout this time period, by early 2021, hunters had harvested 11,424 deer from state parks. Moving forward as state parks continue to uphold the mission, staff are collaborating with MDC to offer earlier hunts to attract more hunters, and considering other ways to manage deer in parks mostly in urban or suburban areas where firearms may not be an option for acceptable weapons. 🦌

Allison J. Vaughn is the Natural Areas Coordinator with the Missouri Department of Natural Resources.

Contact: allison.vaughn@dnr.mo.gov

References Cited

F. Leland Russell, David B. Zippin, and Norma L. Fowler. Effects of White-tailed Deer (*Odocoileus virginianus*) on Plants, Plant Populations and Communities: A Review. *The American Midland Naturalist*. 146(1), 1–26, (1 July 2001)

A deer herd in front of the Harry S Truman SP Visitor Center in Fall 2021. The park last witnessed a hunt in 2019 and spotlight and browse surveys indicate a need once again in 2022.

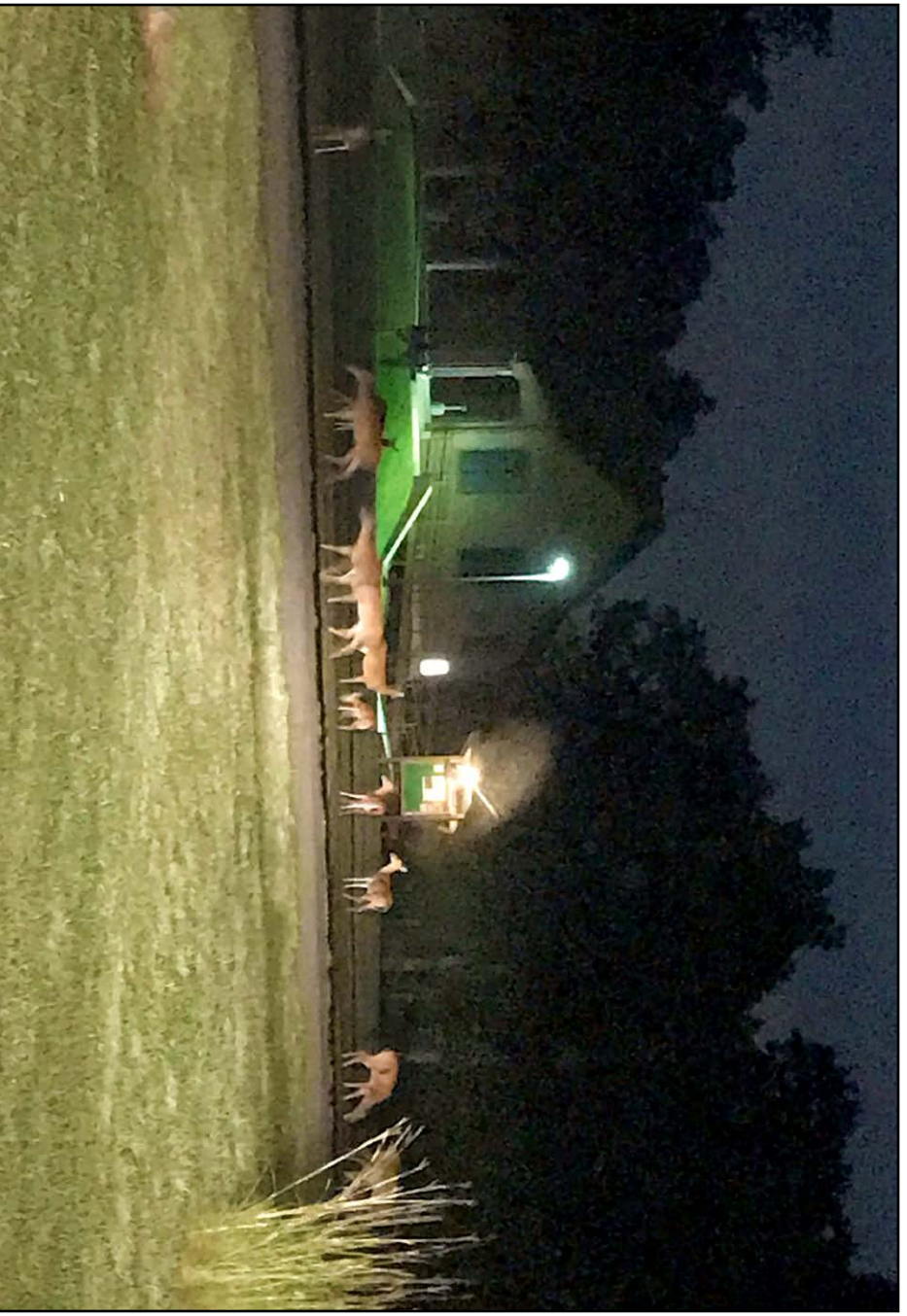


Photo by Allison J. Vaughn



Ken McCarty in an old growth bald cypress grove during a recent boundary survey for the Big Oak Tree State Park Hydrology Project, scheduled to begin construction in 2022. The standing cypress knees represent historic hydrology for this part of the park.

Ken McCarty receives prestigious National Natural Areas Association Carl N. Becker Stewardship Award

by Allison J. Vaughn

At the 2021 Natural Areas Association (NAA) Virtual Conference in October, Ken McCarty of the Missouri Department of Natural Resources was awarded the prestigious Carl N. Becker Stewardship Award. This is one of the highest honors the NAA bestows and is given to an individual or group in recognition of excellence and achievement in managing the natural resources of reserves, parks, wilderness and other protected areas. It is given in honor of Carl N. Becker, former NAA president and a

great conservation leader whose skills benefited natural areas conservation locally, regionally and nationally.

McCarty was nominated by his colleagues for his long career with Missouri State Parks that spans 36 years of protecting Missouri's natural resources. He remains a leader in the field of ecology and natural history and one of the early proponents of prescribed fire in woodlands in state parks. His research on deer herbivory helped develop a managed hunt program in state parks in the 1980s and continues to guide park management. In recent years, he has collected and curated a native bee collection from state parks, a project that he works on tirelessly in his free time as well.

He has been instrumental in the restoration, preservation and management of many of the 91 parks and historic sites throughout the state of Missouri, in addition to guiding management of 38 natural areas within state parks. There is not a single individual event or achievement that served as the basis of his nomination, but rather a body of work that has brought Missouri State Parks and Missouri Natural Areas System into the form they are today.

McCarty was hired by Missouri State Parks in 1986 to work as the Natural Areas Coordinator for the park system and to work alongside members of the committee. He has served on the committee for much of his career and served as the MDNR Chair from roughly 2003 to the present. His hands-on and managerial approach within Missouri State Parks has allowed many areas of our state parks to be included within the Missouri Natural Areas System. Much of this is based upon restoration efforts that have encompassed upland and bottomland prairies, glades, woodlands, forests, fens and marshes. He helped to initiate many of the first large-scale glade and woodland restoration projects in Missouri, and still provides guidance and oversight to such projects today. Ken's work is not simply within the boundaries of Missouri State Park, as he helps with statewide and region-wide collaborative planning projects including Missouri and Mississippi rivers restoration plans. He works across agency lines

to help guide other agencies in sound resource management decisions and is respected as one of Missouri's best landscape ecologists.

In the 1990s, he investigated solutions to the altered hydrologic regime at Big Oak Tree Natural Area that was shifting the forest cover away from the large eponymous oaks to favor more drought-tolerant species out of character with the historic landscape. This is not a recent issue and McCarty has been trying to find meaningful ways to restore the hydrology of the park over the last 25 years. After many attempts in conjunction with other proposed U.S. Army Corps of Engineers projects, the time came to work towards this goal by other means. Today, after securing funding and neighboring landowner consent, the project is making headway and is coming to absolute fruition in the next few years. For McCarty this would be a major achievement as it has been a desired project for a large portion of his career. For the Missouri State Park system and the Missouri Natural Areas System, this would also be a major accomplishment in bringing about a major restoration project on one of the oldest and last remaining stands of old-growth, bottomland hardwood forest and swamp in Missouri. McCarty's tireless efforts in the field of landscape ecology, his diplomacy and leadership earned him this award that celebrates his career with Missouri State Parks. 🌿

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Allison J. Vaughn is the Natural Areas Coordinator with the Missouri Department of Natural Resources.

Contact: allison.vaughn@dnr.mo.gov

MoNAC Newsletter Mailing List

To receive notification when new issues of the Missouri Natural Areas Newsletter are posted, e-mail Michael.Leahy@mdc.mo.gov. This list-serve is *only* used to notify people of the link to the current natural areas newsletter web posting.





Island Branch stream as it traverses the valley in the recently designated Island Branch Natural Area.

Natural Areas Designated in 2021

by Mike Leahy

Designating land as a natural area requires great effort involving field visits, research into the area's natural history, and building maps to insure the area includes the best remaining examples of natural community types. In June, the Missouri Natural Areas Committee convened to finalize the nominations of two new natural areas and the expansion of another. One key aspect of the designation process is the securing of signatures from the directors of the Missouri Department of Conservation and the Missouri Department of Natural Resources, and leadership of additional land managing agencies that own the natural area. The signature process has now been completed. The three new areas are detailed below:

Island Branch Natural Area (Shannon County)

This new natural area designation covers 1,905 acres of land owned by the Missouri Department of Conservation and the L-A-D Foundation/Pioneer Forest. The centerpiece of this outstanding site is a high-quality, spring-fed headwater Ozark creek valley that is a tributary of the Jacks Fork River. The associated valley supports important karst, aquatic and terrestrial natural communities. The cave system feeding the scenic cave spring is the second longest known cave in Shannon County. The natural area boundaries encompass the underground footprint of the cave.

Island Branch supports 20 different aquatic and terrestrial natural community types providing habitat for 500 native plant species, including 60 species with a coefficient of conservation value of 7 or higher. Eleven species of conservation con-

cern utilize the site ranging from the cerulean warbler to the grotto salamander and forked aster (*Eurybia furcata*). The eponymous stream system contains a variety of seepage zones and fen wetlands framed against moist dolomite cliffs and dry-mesic dolomite forest that grades upslope into chert woodlands. Four spring runs and 10 caves have been documented in this valley highlighting the karstic nature of this site.

Greer Spring Natural Area (Oregon County)

As one of the most significant natural features in Missouri, Greer Spring is the second largest spring in Missouri with a mean daily discharge of approximately 210 million gallons per day. It also has the longest spring branch of all the first magnitude springs in the state, flowing just over a mile before entering the Eleven Point River. This is a state and nationally significant geologic feature of a phreatic spring. In addition to the geologic significance of Greer Spring, it is a significant aquatic natural community supporting

a diverse assemblage of native fish species and aquatic invertebrates, including some species of conservation concern such as the coldwater crayfish (*Faxonius eupunctus*). The flora of the spring branch and associated Ozark fens is diverse as well. At least 14 species of conservation concern utilize this site.

Greer Spring is critically important to the hydrology of the Eleven Point River, a National Wild and Scenic River. For example, the spring provides 90% of the low flow volume of the river where it passes under Highway 19. Even 20 miles downstream, at the Highway 160 crossing, the spring provides 70% of the low flow volume. The recharge zone for the spring is large, having been documented by dye-traces as long as 30 miles. The spring branch provides habitat for 15 native fishes: bleeding shiner, banded sculpin, black redhorse, central stoneroller, chain pickerel, creek chub, golden redhorse, green sunfish, largescale stoneroller, northern hogsucker, northern studfish, Ozark sculpin, rainbow darter, redspotted sunfish, and shadowbass. Greer Spring has a long

Greer Spring in the fall as it feeds the Eleven Point River.

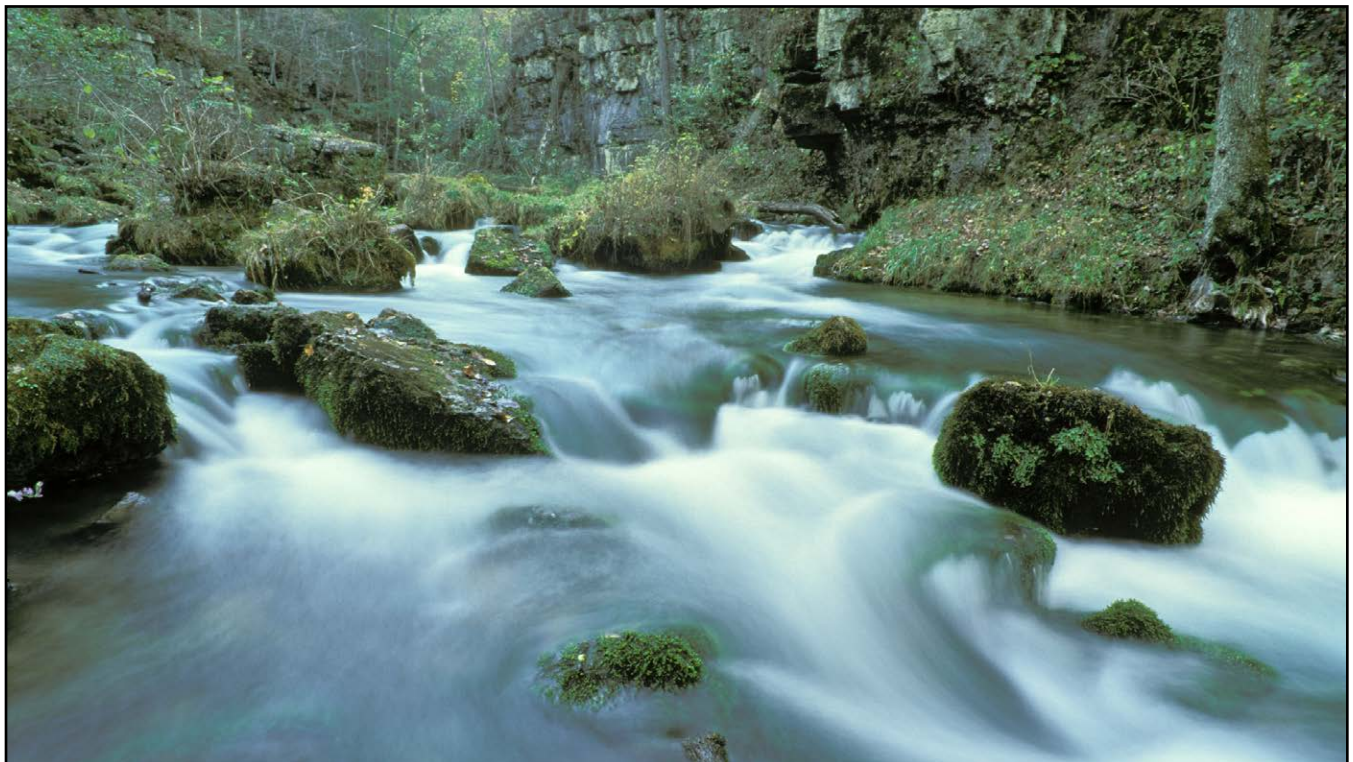


Photo by Jim Rathert, retired MDC

human history as well, as all of Missouri's large magnitude springs have had. However, compared to the other first magnitude springs of Missouri (e.g., Big Spring) Greer has a much more remote setting. It is also a National Natural Landmark recognized by the National Park Service. The natural area consisting of the spring, spring branch and surrounding slopes encompasses 1,097 acres of the Mark Twain National Forest. This site was purchased from the Dennig family in 1988 by Leo Drey. Drey then held it until 1991 when the Forest Service was able to acquire it.

Cowards Hollow Natural Area addition (Carter County)

Cowards Hollow was originally nominated in 1991 as a natural area for its significant geologic features including an unusual chert shut-in with massive chert beds. This expansion of Cowards Hollow (202 acres) includes a high-quality Ozark headwater stream, an extensive marsh complex influenced by karst hydrology and beavers (*Castor*

The chert shut-ins and falls at Cowards Hollow Natural Area are the centerpiece of the original natural area (56 ac.), recently expanded to include 202 acres of marsh, Ozark fen and terrestrial natural communities.



Photo by Susan Farrington, MDC

canadensis) and a mosaic of riparian communities supporting 277 native plant species.

Cowards Hollow creek is a first and second order creek in the natural area expansion area. The creek is well-established and strewn with boulders, bedrock and very little fine sand or gravel sediments with deep pools that support at least eight native fish species (central stoneroller, creek chub, creek chubsucker, current darter, green sunfish, largescale stoneroller, rainbow darter, Southern redbelly dace) and one native crayfish species (spottail darter). Groundwater within and possibly beyond the Cowards Hollow watershed is perched by the massive chert beds along the upper part of the natural area. In addition to flow from Cowards Hollow itself, there are 19 known karst seeps, five springs, and three fens discharging into the wetland. 🌿

Mike Leahy is Natural Areas Coordinator with the Missouri Department of Conservation
Contact: Michael.Leahy@mdc.mo.gov

E.O. Wilson, longtime advocate for nature dies at 92

from The Natural Areas Association

The Natural Areas Association (NAA) is mourning the loss of Edward O. “E.O.” Wilson. Often referred to as Darwin’s natural heir, Wilson passed away on Sunday, December 26, at the age of 92.

Long considered one of the world’s leading authorities on natural history and conservation, Wilson was a preeminent scientist, naturalist, author, teacher and an inspiration to many who study the natural world. Both revered and controversial, Wilson was a scientific icon with a long list of published works that documented his findings and theories related to the study of entomology and evolution.

Wilson led research and taught at Harvard University for several decades. Upon retiring, rather than resting, he continued his research and launched a new area of focus—the protection of the planet in order to avoid its destruction due to human inhabitants.

Through the E.O. Wilson Biodiversity Foundation established in his name, Wilson realized a lifelong dream in 2008, when the Encyclopedia of Life went online, documenting 1.9 million living species on earth.

As a co-founder of the Half-Earth Project, Wilson wanted to inspire and educate the human population regarding the need to preserve and steward natural resources in order to avoid the extinction of species and the destruction of Earth as a viable planet for life. The development of the Half-Earth Project was based upon his belief that if half of the land and half of the sea were preserved, that would be sufficient to reverse the species-extinction crisis and ensure the long-term health of the planet.

“Through the work of natural areas practitioners, Dr. Wilson’s contributions to the field of biodiversity conservation are realized in every place and with every organism that is protected through the stewardship of land and water,” said Lisa Smith, Executive Director, NAA. 🌿

2022 Event Calendar

February 1–3, 2022

Annual Missouri Natural Resources Conference

Osage Beach, Missouri
<https://mnrc.org>

February 13–16, 2022

82nd Annual Midwest Fish and Wildlife Conference

Des Moines, Iowa
<http://www.midwestfw.org>

February 21, 2022

Winter Raptor Field Trip to Penn-Sylvania Prairie with Jeff Cantrell

Dade County, Missouri
<https://moprairie.org/events>

August 1–5, 2022

Joint Meeting: 28th Annual Bobwhite Technical Committee and 9th National Quail Symposium

<https://tinyurl.com/4k6j2yje>

August 4–10, 2022

Herpetofauna Disease Conference

Knoxville, Tennessee
<https://tiny.utk.edu/CARD22>

September 6–9, 2022

Natural Areas Conference

Sponsored by the Natural Areas Association.

Duluth, Minnesota
<http://naturalareas.org>